ANSWERS: Crystal ball: Calorimetry calculations

1) i) $CH_3OH + 1½O_2 \rightarrow CO_2 + 2H_2O$
ii) mass of water = 12g (as 1m of water = 1g)
change in temperature of the water is 35 ºC
Heat of reaction = 12 x 4.18 x 35 = 1755.6J

1 mole of methanol = 32 g
? moles = 2g = 2/32 = 0.0625moles

0.0625 moles of methanol = 1755.6J
so 1 mole of methanol = 1755.6/0.0625 = 28089.6J = 28.089kJ (28.1J to 3 sig figs)

2) i) 1 mole H_2O = 18g
To melt 1 mole of water 8.03 kJ are required
number of moles of H_2O in 350g is = 350/18 = 19.44
Energy required to melt 350g of water is 19.44 x 8.03kJ
= 156.138kJ

ii) 1 mole of butane releases 2874 kJ
? moles of butane releases 156.138kJ of energy = 156.138/2874 = 0.05432 moles required

iii) $\Delta H = m \times c \times \Delta T$
= 350 x 4.18 x 90
= 131.670kJ energy needed to heat the ice to hot water
1 mole of butane releases 2874 kJ of energy
moles of butane required is 131.670/2874 =0.0 458141kJ
remembering to add on the moles of butane required to melt the ice from part ii) 0.05432
therefore, total moles of butane required is 0.100134kJ
mass of butane required = 58 x 0.100134 = 5.80778g

3) i) The mass of water is 75g as 1mL of water is approximately equal to 1g
density = mass/volume so mass of NaOH is 1.2191 x 25 = 30.4775
total mass of water and NaOH is 105.4775g
change in temperature (ΔT) = 27 – 20 = 7˚C
Heat of reaction = 105.4775 x 4.18 x 7 = 3086.27J or 3.086kJ (round up as 3.09kJ)

ii) 25mL of 20% w/v NaOH solution
20g of NaOH per 100mL H_2O, so in 25mL solution there is 5g of NaOH
number of moles of NaOH is 5/40 = 0.125 moles
So, the enthalpy change would be 3.08627/0.125 = 24.690kJmol^{-1}

4) Heat of reaction = 4kJ = 4000J = mass of water x 4.18 x 65
so, mass of water is 4000/(4.18 x 65)
= 14.7g of water (assuming that 1mL or water equals 1 g of water, also you'll notice that the value of 5g for the mass of ethanol is not required for this calculation)